



The Exploration for shale

Why we're doing this, why it's safe, and why it's good

I-SEE Seminar, University of Bath

March 4 2014

Andrew Quarles, Cuadrilla Resources

What is exploration, today?



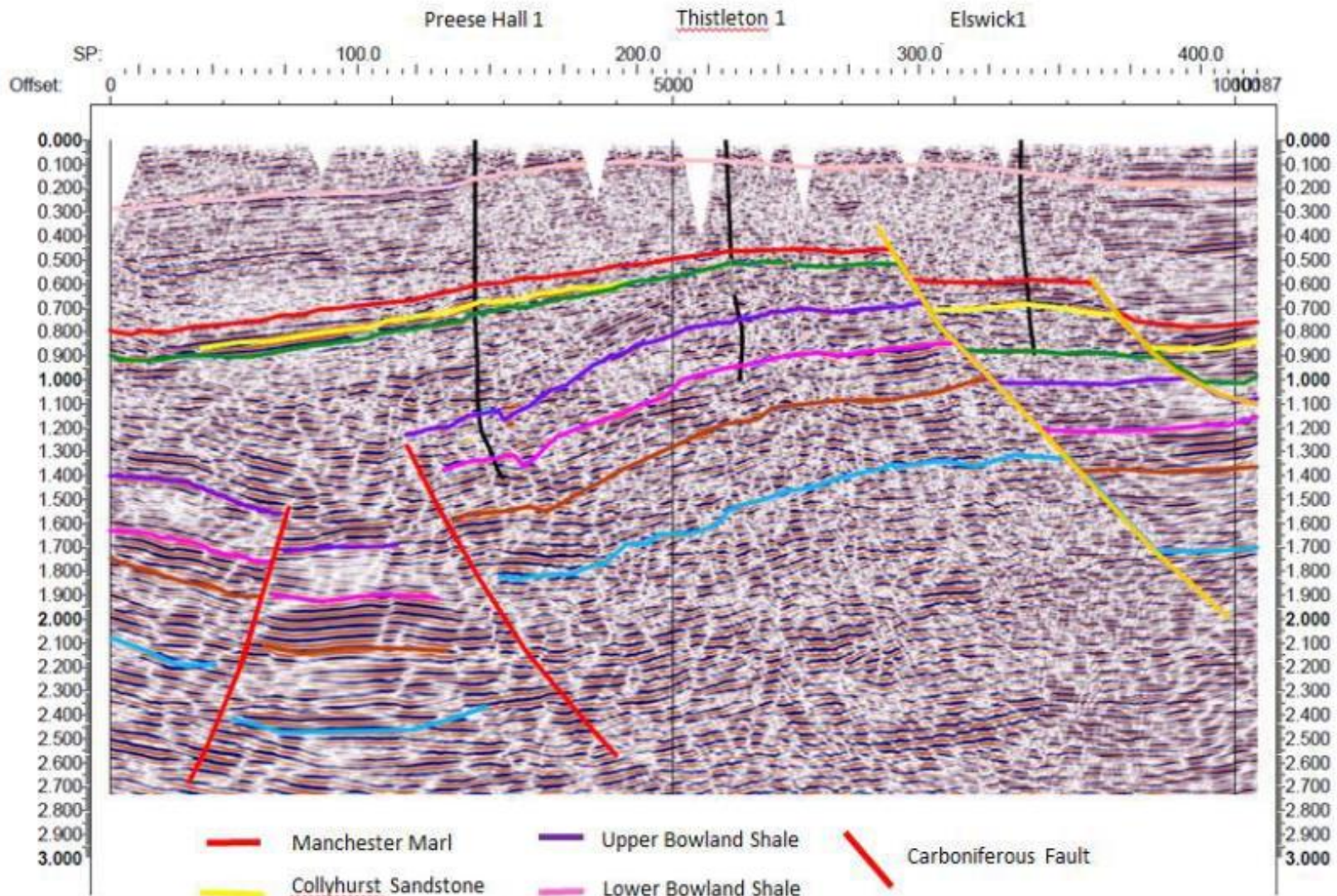
(Welcome back for Ben Saunders and Tarka L'Herpiniere, on their completion of Scott's iconic 1,795 mile Terra Nova route from the very coast of Antarctica to the South Pole and back.)



<http://scottexpedition.com/about>

Another view of exploration

Preese Hall-1: UK's Shale Gas Discovery Well



Three key points

1

Shale gas is revolutionary and the UK can play a role in these changes

2

The UK shale gas industry must communicate its experience

3

Gas consumption must be one of the key strategies in reducing CO₂ emissions

Cuadrilla

- Formed in 2007, UK company
- Early entrant to shale gas in Europe
- Prospective and diversified acreage portfolio
- Backed by industry-specialist funds

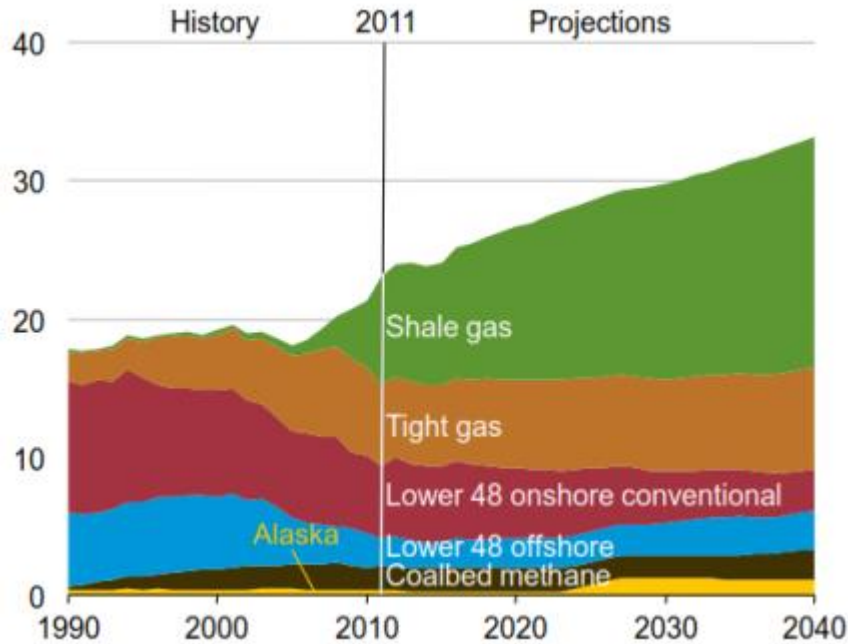
Exploration assets

- Netherlands \approx 680,000 acres
- Bowland basin \approx 293,000 acres
- Weald basin \approx 192,500 acres
- Poland \approx 440,000 acres

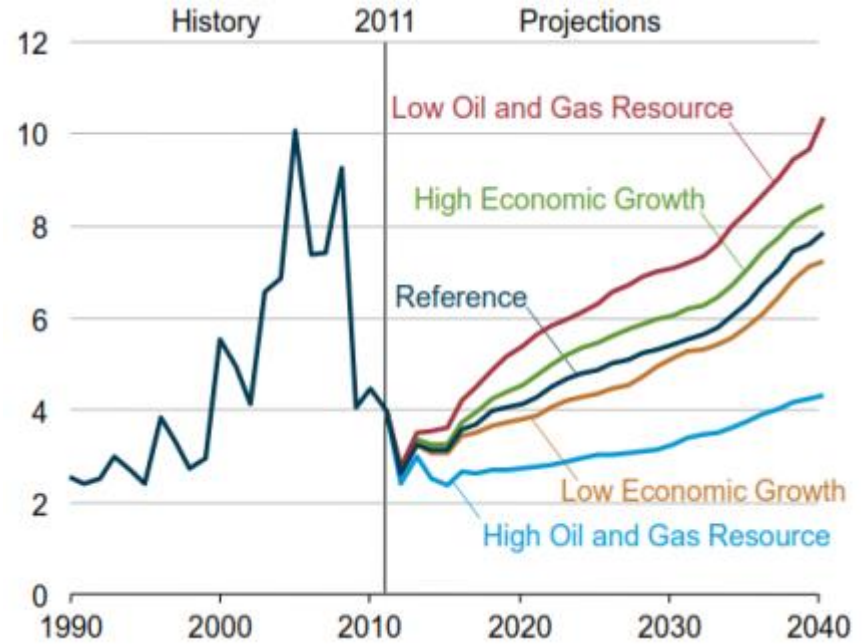


Shale Gas: breaking the rules

Annual US Natural Gas Production (tcf)



US Natural Gas Price \$/mmBtu

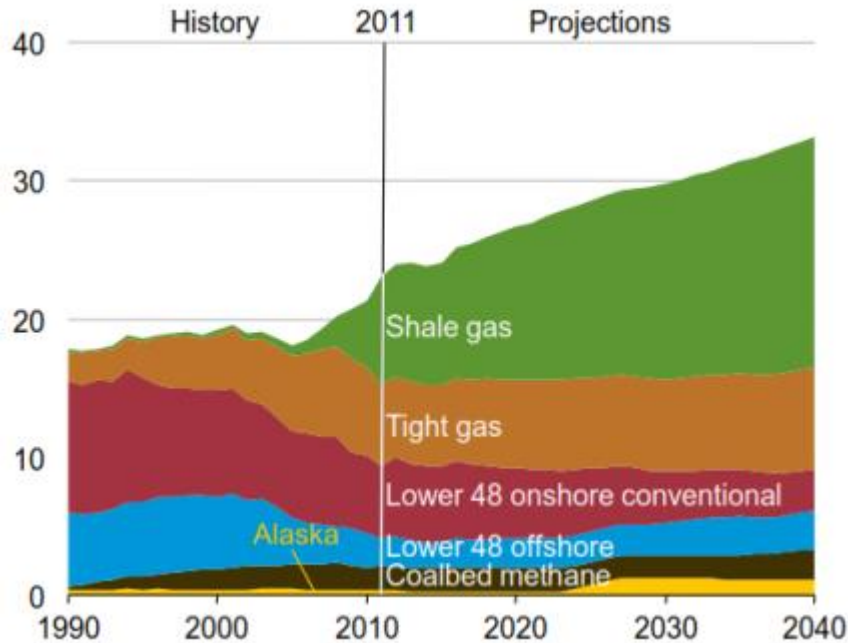


from 2013 Energy Information Agency Annual Report

More Natural Gas, Lower Prices

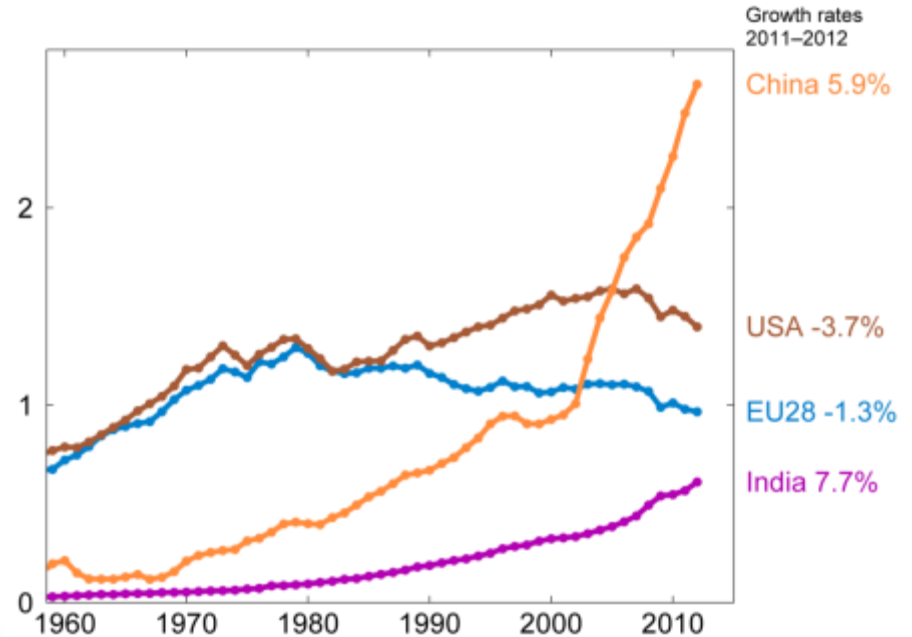
Shale Gas: breaking the rules

Annual US Natural Gas Production (tcf)



from 2013 EIA Annual Report

CO2 Emissions (Top 4 emitters) GtC/yr



Global Carbon Project 2013

More Natural Gas, Lower CO2 emissions

Bowland Shale is a massive resource

BGS:

"The lower limit of the range is 822 tcf and the upper limit is 2,281 tcf, but the central estimate for the resource is **1,329 tcf**"

- Over 1000m (>3300 ft) thickness of shale
- 1000's feet below aquifers
- Very close to major gas pipeline infrastructure

UK annual gas consumption \approx **3.2 tcf**



Cuadrilla and Bowland license

- Drilled 3 wells
 - Preese Hall-1 drilled to 9,100 feet (partially fractured)
 - Grange Hill-1 drilled to 10,700 feet
 - Beconsall-1 drilled to 10,500 feet
 - Acquired 3D seismic data
- Still in exploration stage
 - Applying for temporary planning permission to drill / fracture/test 8 more wells from 2 sites
 - Need to show that shale gas production is safe and commercial



February announcement



Cuadrilla names fracking exploration sites in Lancashire



Exclusive: Shale gas explorer Cuadrilla identifies two sites between Blackpool and Preston for fracking, scaling back original plans to frack at seven sites



A Cuadrilla drilling rig in Lancashire. The company says it has "robust safety measures in place" to



Fiona Harvey and Adam Vaughan
The Guardian, Tuesday 4 February 2014 14:16 GMT
Jump to comments (308)

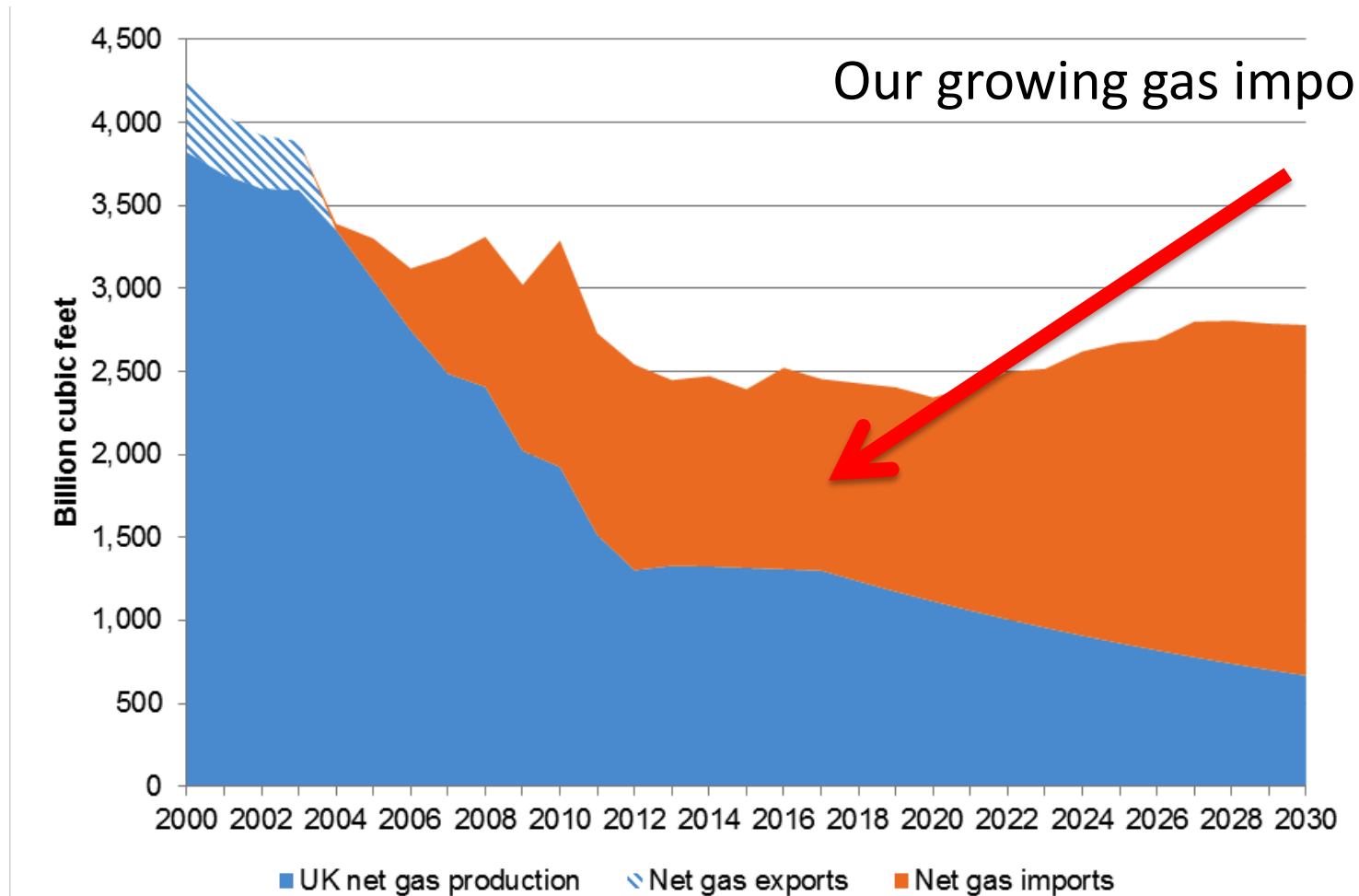


An engineer displays a lump of shale rock at the Cuadrilla shale fracking facility in Preston, Lancashire. Photograph: Matthew Lloyd/Getty Images



What are the potential effects in the UK?

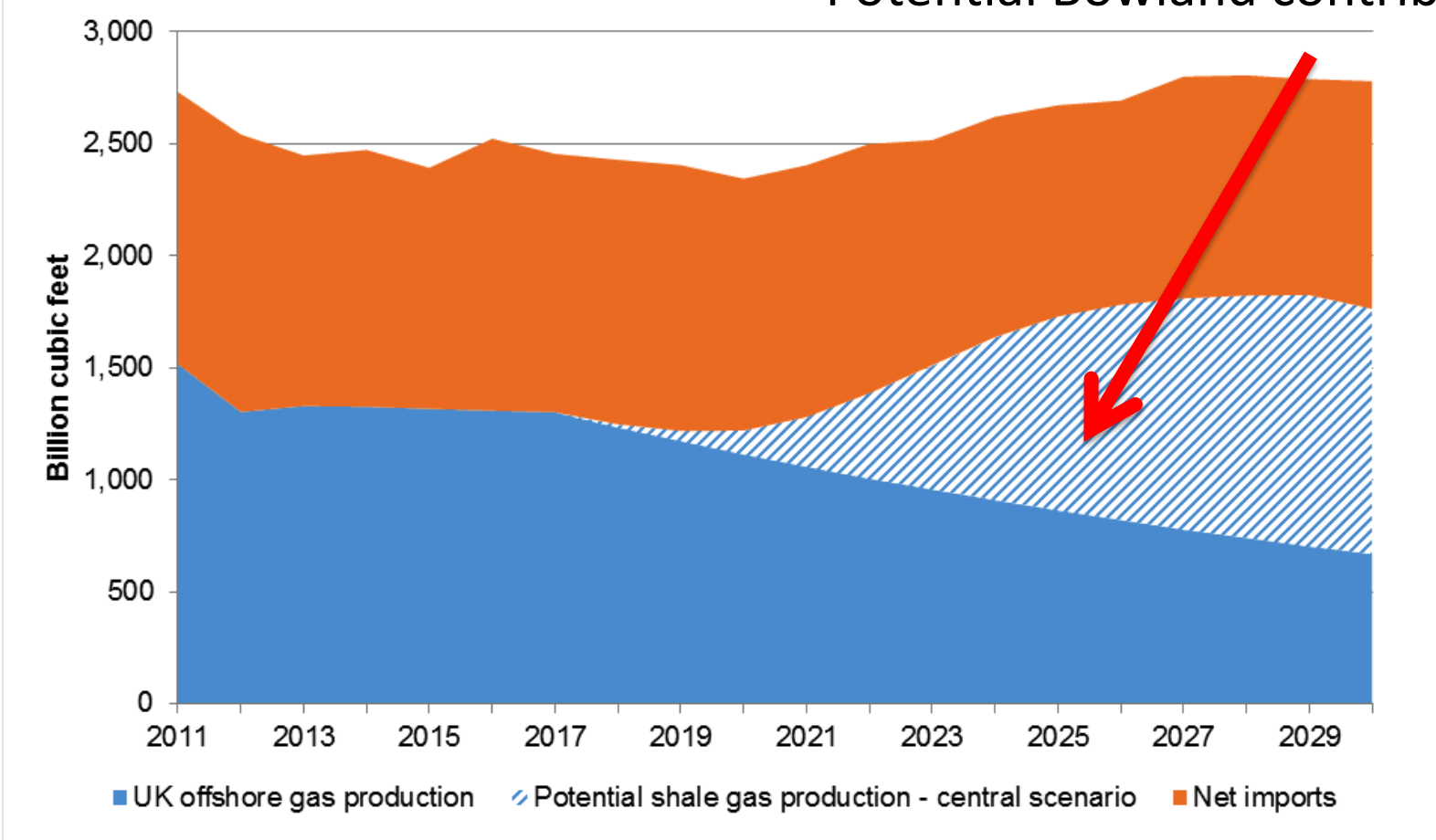
UK is spending £8B on imports now, rising to £16B by 2029



(Source: Department of Energy and Climate Change)

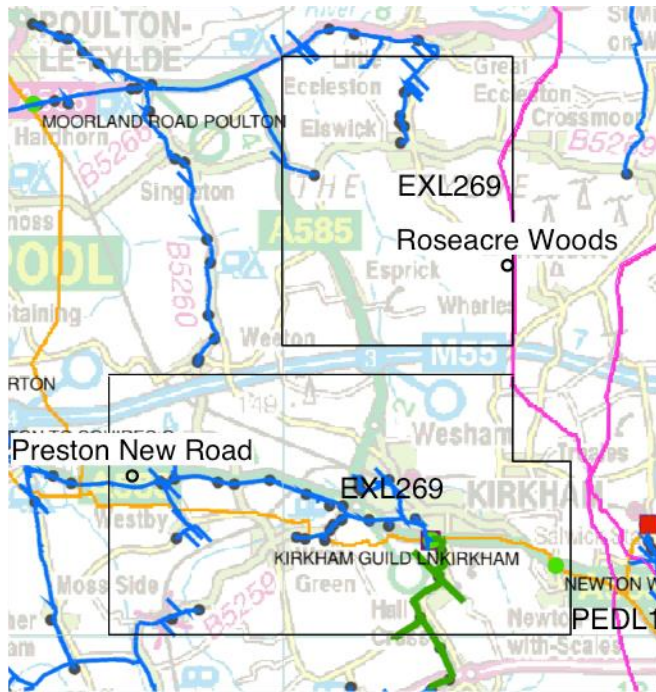
Bowland alone could make a material difference

Potential Bowland contribution

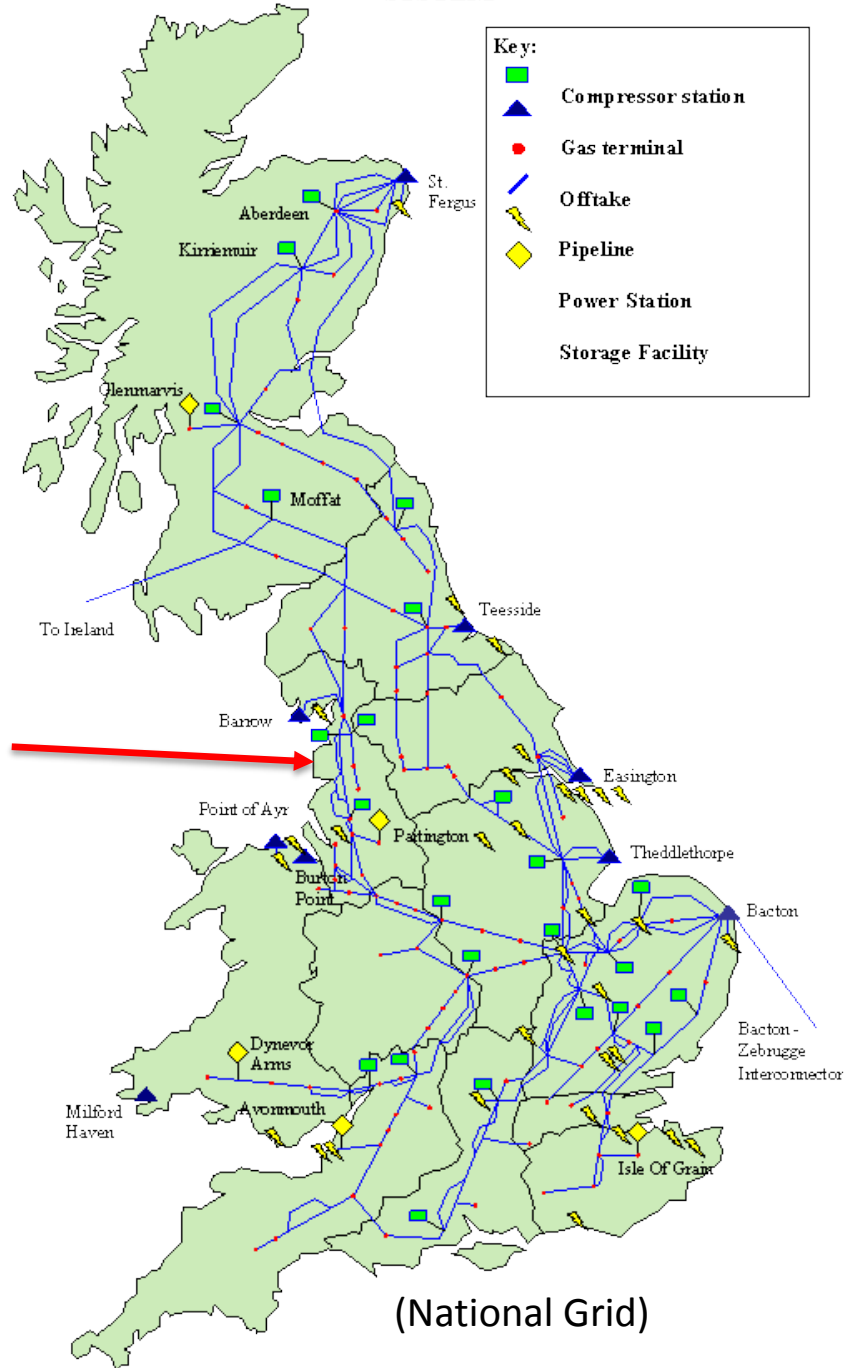


(Source: IoD calculations)

Key infrastructure is already here



THE NATIONAL TRANSMISSION SYSTEM



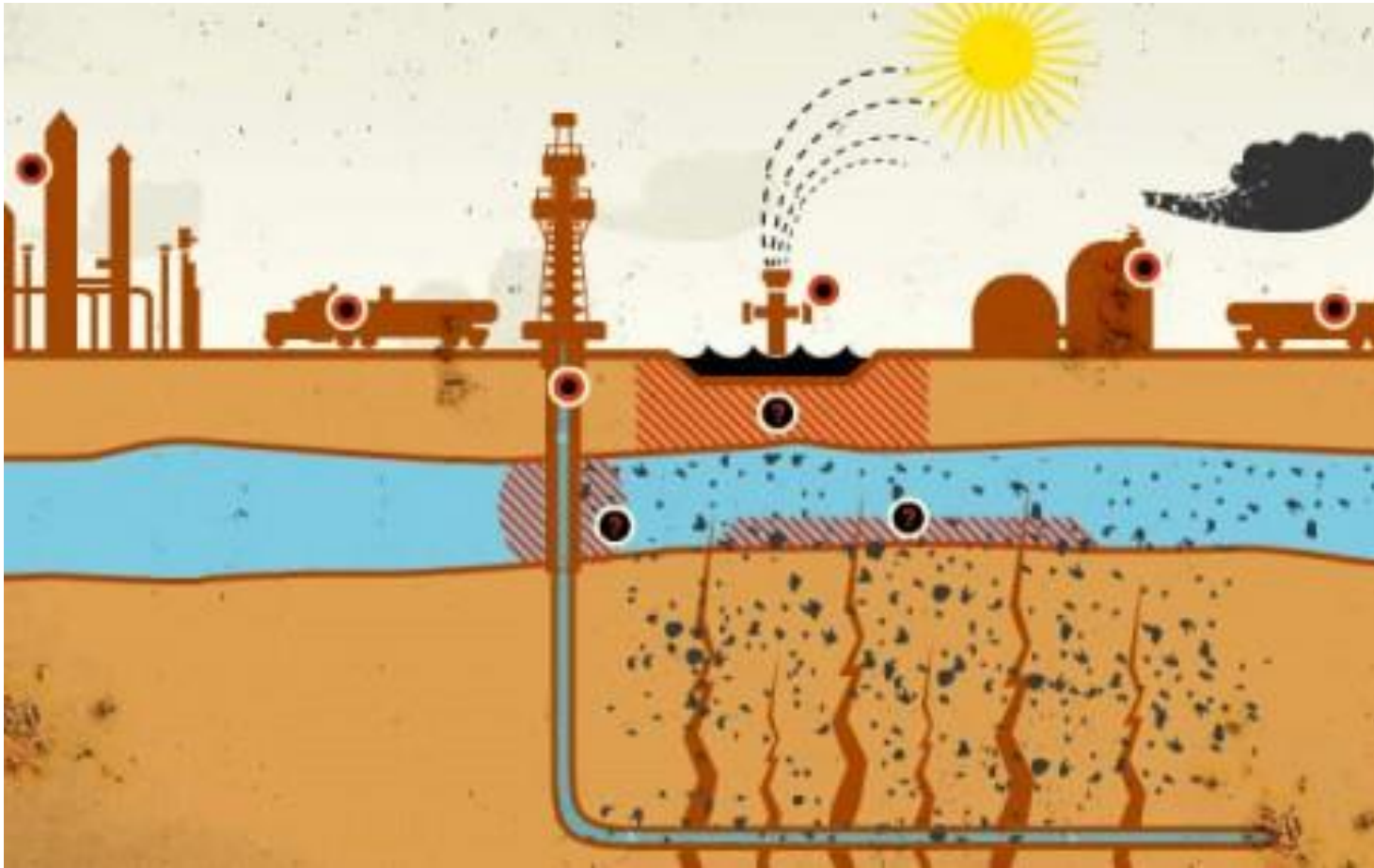
What a successful shale gas industry has to offer

- Meaningful unsubsidized private investment
 - (Bowland alone potential for £50B through 2040)
- Meaningful job creation
- Meaningful energy security contribution (up to 1tcf per annum)
- Highest regulatory standards (environmental, health, safety)
- Small industrial surface footprint -- 100 sites occupy just 2 km²
- Opportunity for “Aberdeen effect”

2

The industry must communicate its experience

The myths



(4th Media 2012)



THE SUNDAY TIMES

Drill deeper into the anti-fracking arguments

Most objections to the process of extraction don't stand up to scrutiny

Tony Allwright Published: 2 March 2014

Recently in *The Sunday Times*, author Ben Judah explained how Vladimir Putin's Russia was "hideously exposed" should the price of oil ever tumble. Something similar could be said of most Opec nations. But the oil price will tumble, bowled over by the trillions of barrels of oil and gas waiting to be liberated throughout the world — including in Leitrim — by the revolutionary force that is fracking. Already, limited fracking in America has reduced gas prices by 25% while stabilising those of oil and coal.

Objections are delaying fracking across the rest of the globe, falling into six categories — all spurious. The first is that "fracking results in more hydrocarbons, thus more carbon dioxide". Yes, but that's a function of the hydrocarbons, not their means of extraction. Fracking does consume more energy than free-flowing wells, but the days of easy fossil fuels are gone.

Second, "toxic fracking fluids come back up the wellbore". True, but this is a problem only if the fluids are then released raw into the environment. Good fracking practice involves storing the toxic fluids for reuse, or treating them to remove the toxins, just as in any other industrial process that uses water.

"Fracking can cause surface subsidence" is a third objection. Hydrocarbons are found at depths of thousands of metres. Fracking is confined to the reservoir rock, with each fracture stretching perhaps tens of metres. It is fanciful to imagine fractures can extend several kilometres up through multiple strata of solid rock until they reach the surface, and that pumping crews would be unaware of huge extra volumes vanishing down the hole. It can't happen. America's biggest bunker buster can blast through only 60 metres of concrete.

"Fracking fluids can contaminate ground water" is another cavil. Groundwater lies a couple of hundred metres deep, at most. Again, it is preposterous to suppose fracking fluids can blast their way up and unnoticed, through thousands of metres of rock, to reach groundwater reservoirs. Two years ago, the *Financial Times* declared there was not a single proven instance of such contamination; I am not aware of any case since.

Fifth, "hydrocarbons from fracked wells can contaminate ground water". Similarly, the produced fluids can also never reach the groundwater. This particular scare has been fanned by the polemical anti-fracking movie *Gaslands*. It includes a scene where supposedly gas-laden tap water in Colorado catches fire, said to be the result of deep shales having been fracked. In fact the water was contaminated by methane seeping from coal seams much closer to the surface. The phenomenon long predates any fracking operations.

Finally, fracked wells supposedly "present a noisy eyesore for the countryside". The drilling rig and powerful pumps involved are indeed unsightly and noisy, but this is temporary, just as digging the Dublin Port Tunnel was, briefly, highly disruptive for traffic. After a well is completed, all that's left to see is a set of valves (called a Christmas tree) perhaps three metres high, which can be concealed, while the control cables and the pipeline that takes away the produced fluids are buried.

Furthermore, thanks to directional and multilateral technologies, each well can, in effect, be several wells with sub-surface tentacles spreading for kilometres in all directions. This minimises the number of Christmas trees, and lets them be positioned close together. They can be fenced off in a relatively small area, and hidden from general view behind trees and hedges. Typically, a pad the size of a football pitch might accommodate 18 wellheads. Compared with many factories, office buildings or wind turbines, the visual impact is low.

Fluids can migrate up from the reservoir if the well is poorly built, just as a house with missing roof-tiles will leak. After drilling, a well is always lined with a steel pipe, bonded to the wall with cement. Standard practice is to test the pipe for leaks and fix any anomalies. The solution to such leaks is not to ban houses or wells, but to construct them properly and set up a regulatory regime.

Imagine a world where an occasional mistake due to avoidable incompetence led to blanket proscription. We would have no technology at all — no aircraft, medicines, cars, buildings or internet.

So, no criticism of fracking stands up to scientific scrutiny. They mostly boil down to a fear of the unknown and a special suspicion of oil companies, which in truth they do little to allay. Economics will make fracking unstoppable, and lower energy prices will foster prosperity among consumer countries, while making life tougher for existing exporters such as Russia and Opec.

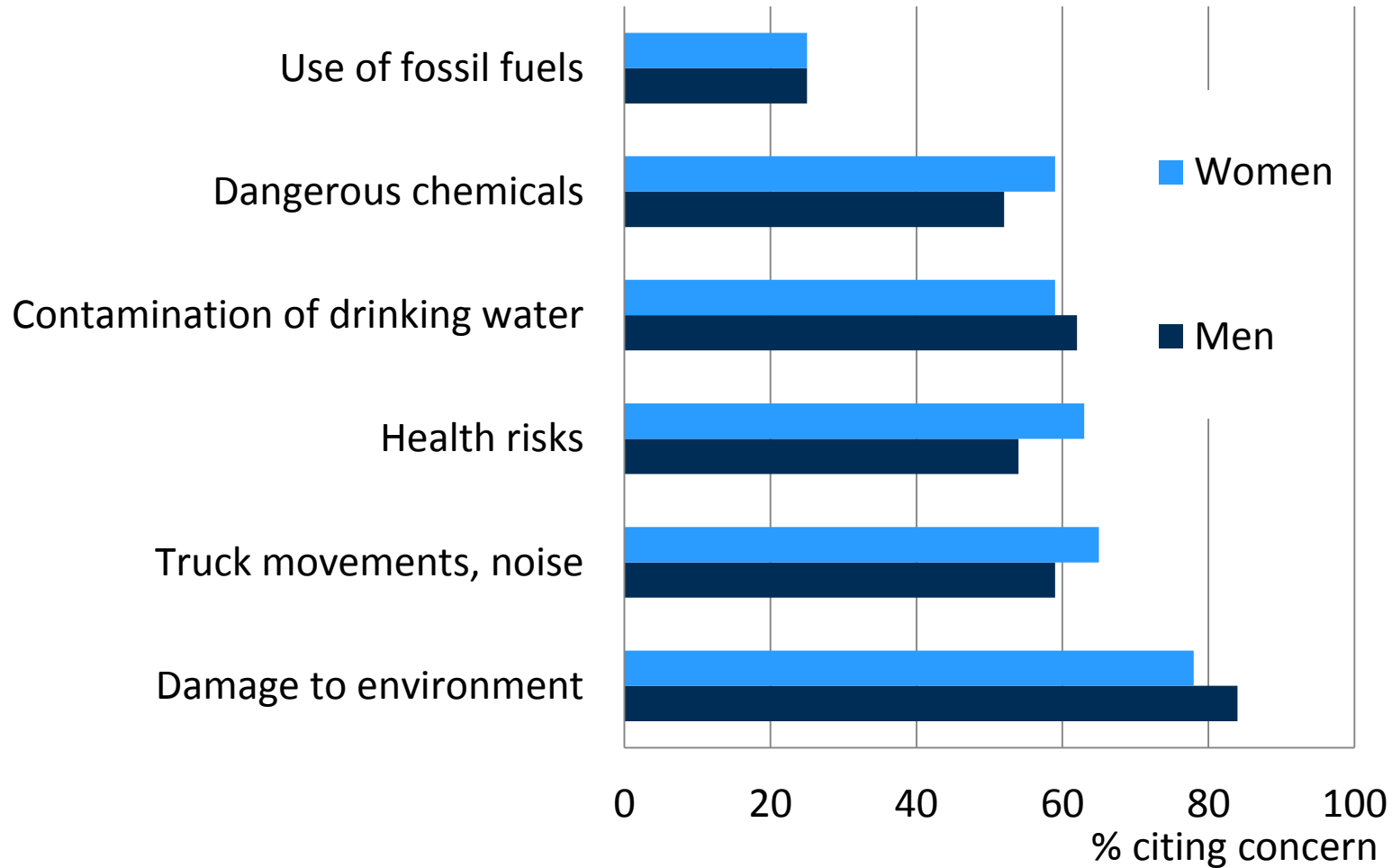
Tony Allwright is an engineering and industrial-safety consultant and commentator



The six big myths

1. Fracking results in more hydrocarbons, thus more carbon dioxide
2. Toxic fracking fluids come back up the wellbore
3. Fracking can cause surface subsidence
4. Fracking fluids can contaminate ground water
5. Hydrocarbons from fracked wells can contaminate ground water
6. Fracked wells supposedly present a noisy eyesore for the countryside

Concerns with a pad in community

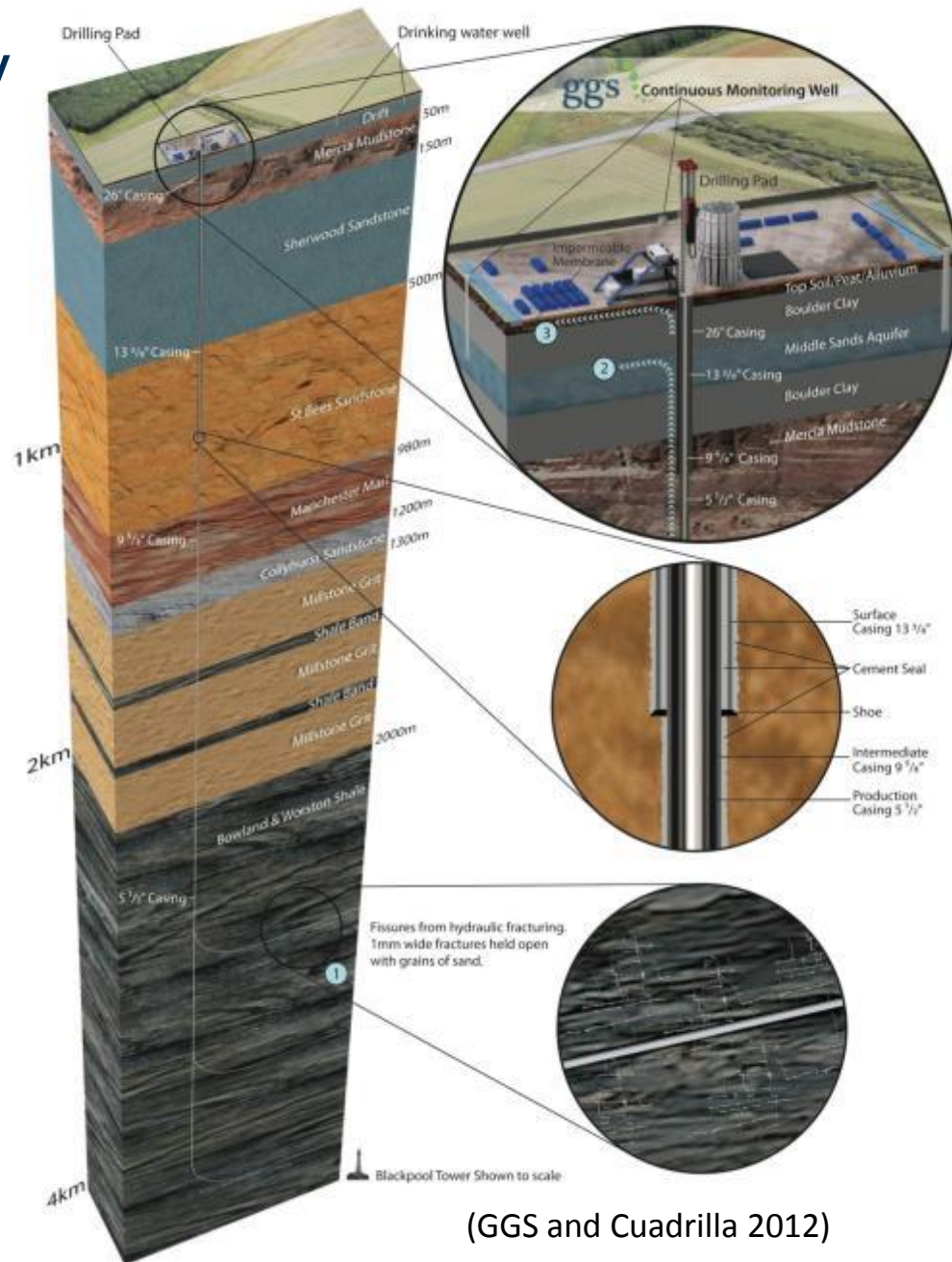


UK – The reality

- Potable aquifer – 5-50 meters
- Saline aquifer – 100-300 meters



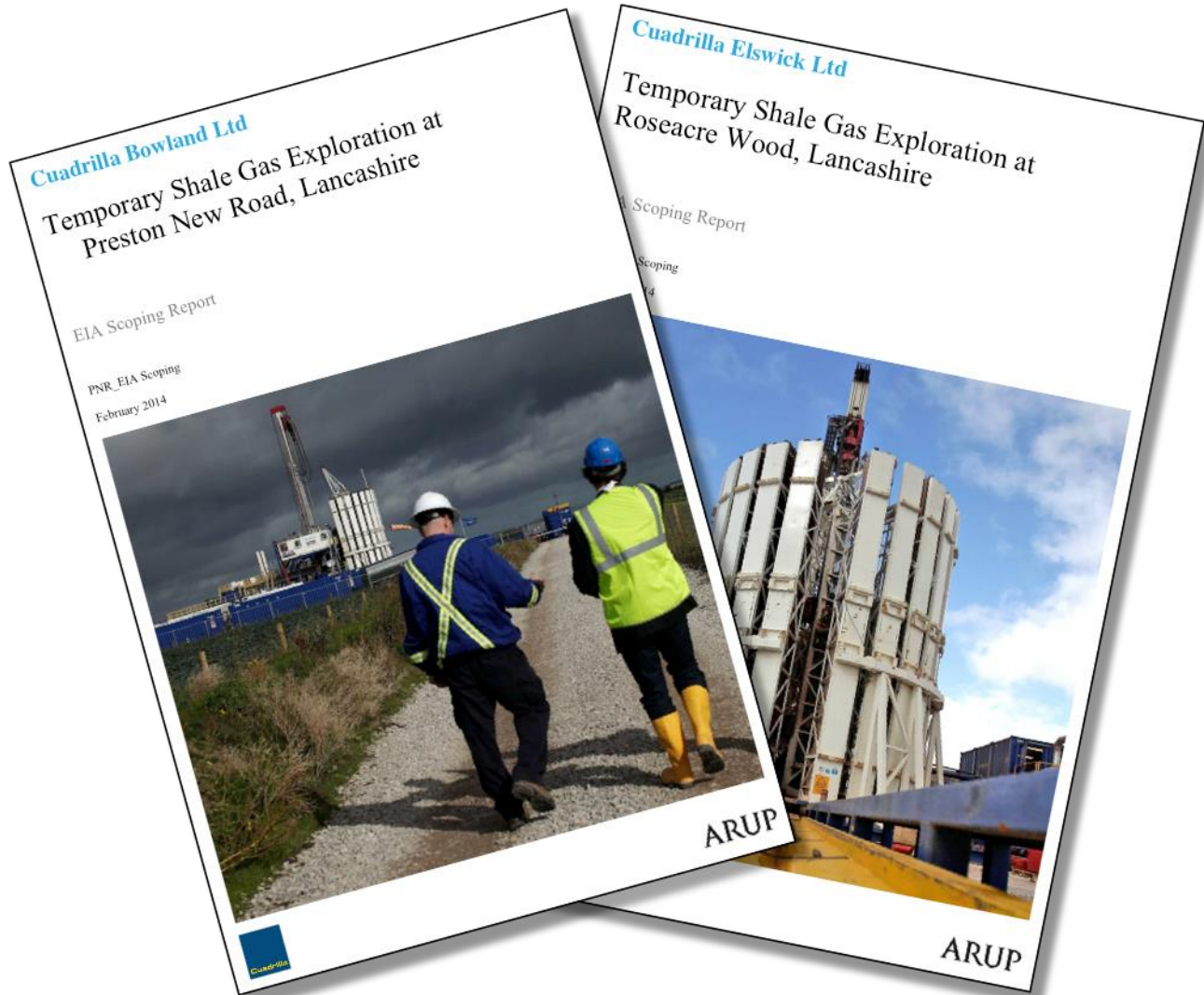
- Shale target 3 KM



(GGS and Cuadrilla 2012)



Environmental Impact Assessment for new sites



Technical areas of assessment

- Air quality
- Archaeology & cultural heritage
- Greenhouse Gas Emissions
- Community and socio-economics
- Ecology
- Hydrogeology and Ground Gas
- Induced seismicity
- Land Use
- Landscape and visual amenity
- Lighting
- Noise and Vibration
- Resources and waste
- Traffic and transportation
- Water resources and flood risk

Environmental Impact Mitigation

1. Baselines: monitor the environment before, during, and after operations: air quality, ground and surface water, noise and seismicity
2. Cuadrilla will only use fracturing fluid that is approved by EA and classified as non-hazardous to groundwater
 - In Lancashire – 99.95% water and sand; 0.05% friction reducer
3. Cuadrilla is piping – not trucking – mains water to site
 - Estimated 1/10th of one per cent of total abstraction (CIWEM 2014)
4. Returned water/ gas separation is in closed-cycle system
 - Returned water contains very low levels of NORM
5. Flaring is regulated in the UK, and is minimized
 - Flaring has been a site practice for 100 years and has not been a health issue for workers in proximity, much less communities

We can never do enough to address the information gaps

- Statutory consultation and non-statutory informational events (16 events, past 24 months)
- Site visits, rig tours
- Speaking to groups, large and small
- Letters, newsletters, answering questions, information line
- Events, sponsorships
- Projects – academia, 3rd parties
- Recommending engagement strategies for regulators



Community benefits announcement – transformational potential

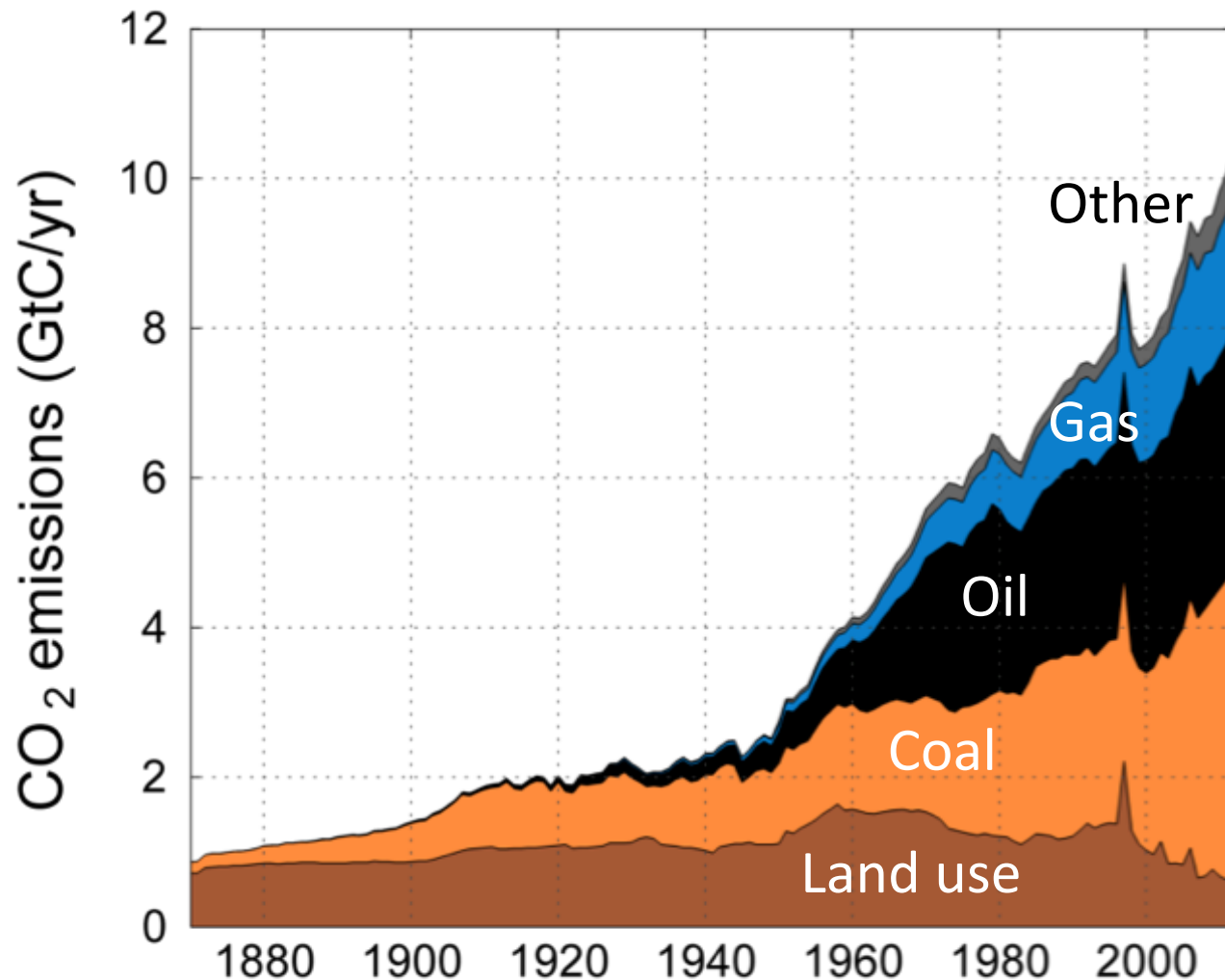
- Communities receive £100,000 for every exploration well that is hydraulically fractured
- Communities receive one per cent of revenues from future shale gas production
 - Potentially, more than £1 billion over a 20 to 30 year shale gas production timescale could be returned to Lancashire communities within the Bowland Basin license area alone



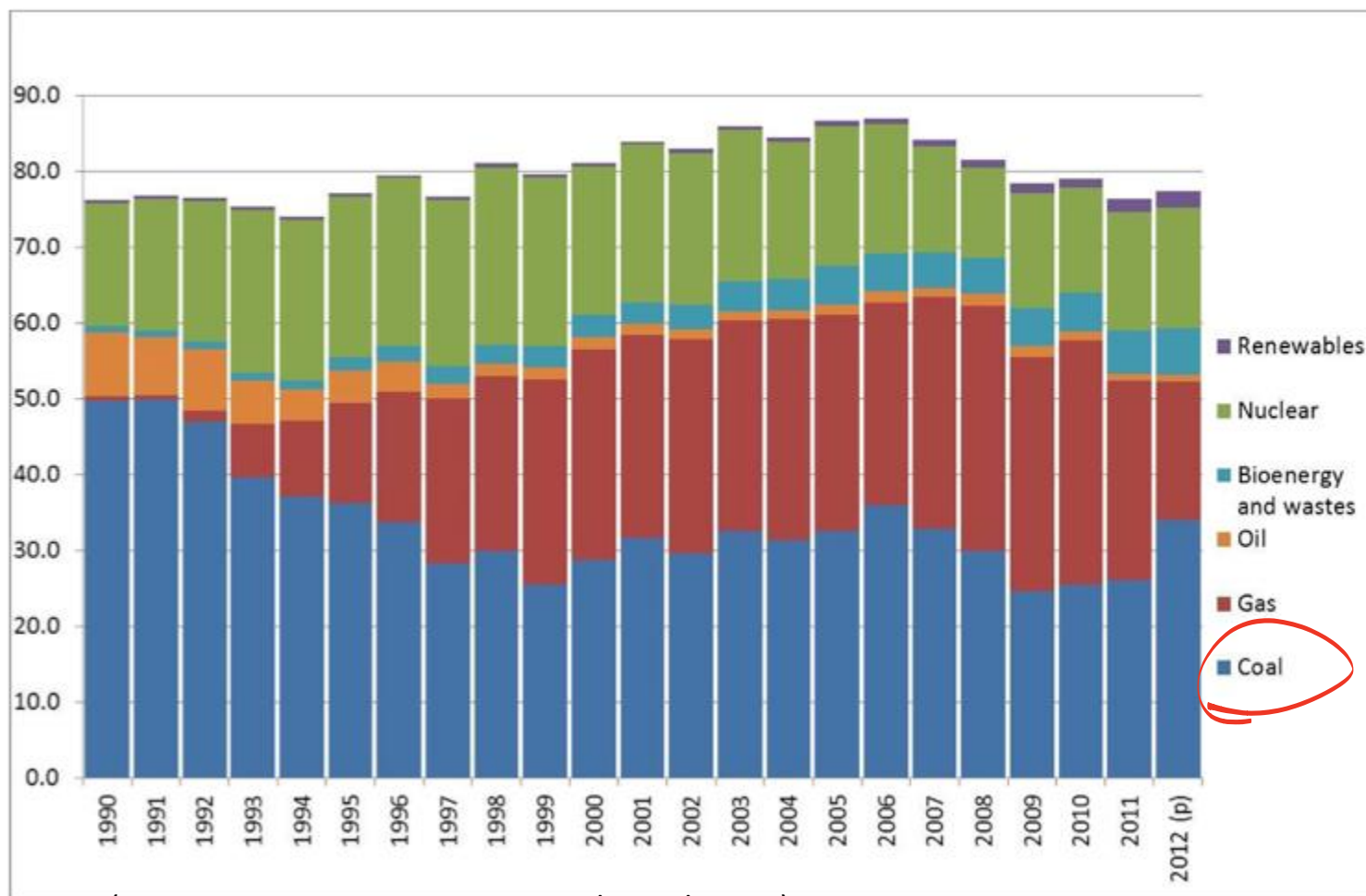
3

Gas is essential if we are serious about reducing CO₂ emissions

In terms of global CO₂ emissions, coal and oil are significantly higher contributors



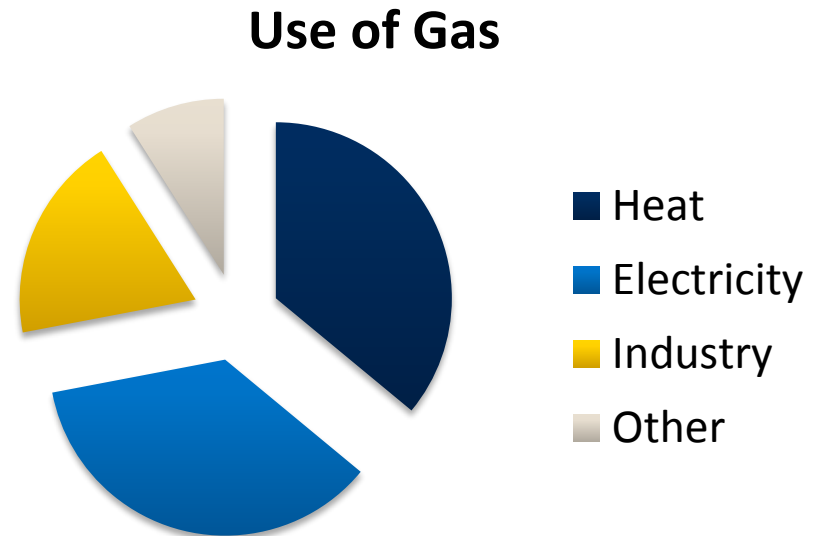
Future mix for UK electricity is gas, nuclear and renewables – but coal is still a factor



(DECC: GHG Emissions 2012, issued March 2013)

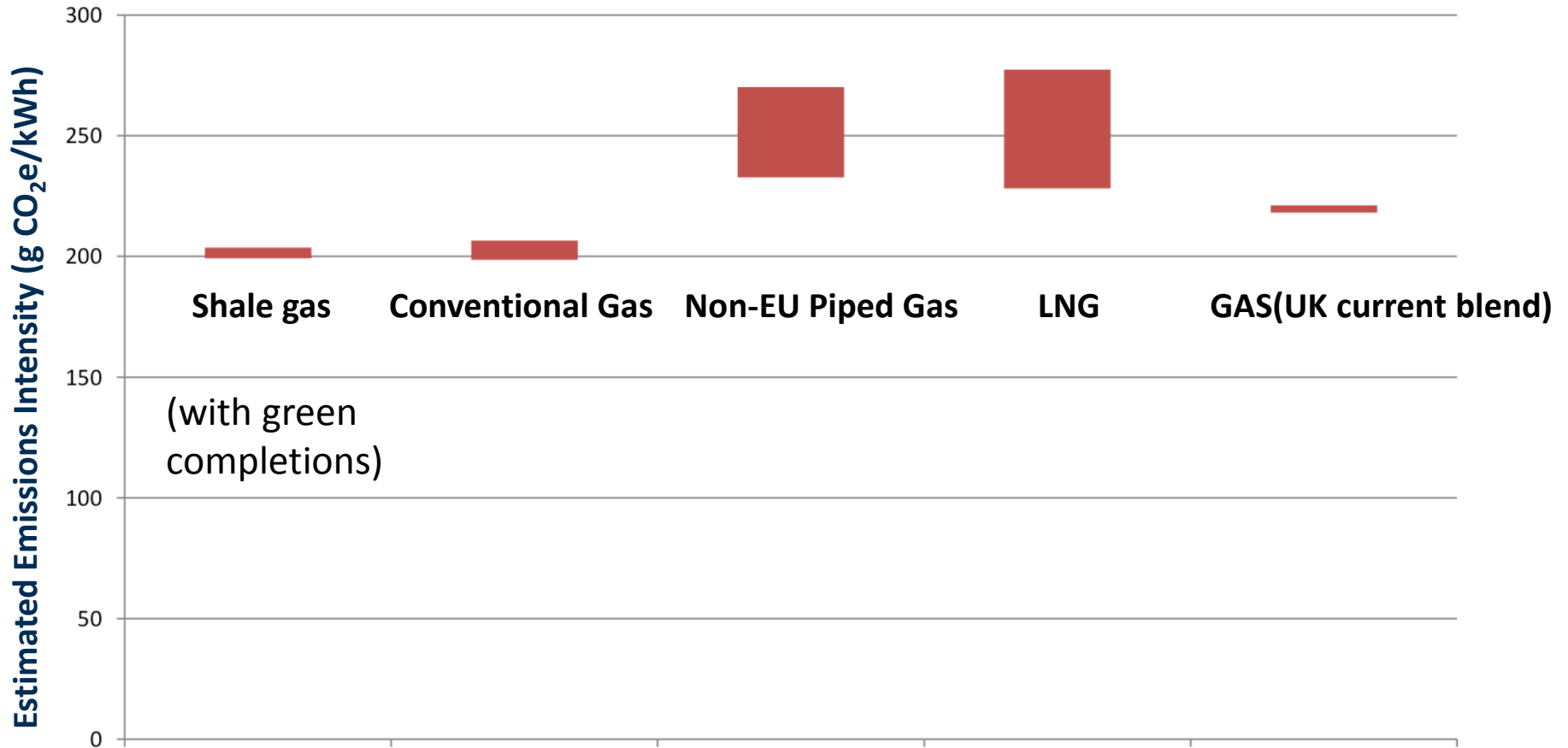
Its much more than “keeping the lights on” 55% of gas goes to heat and industry

- 36% gas goes to heating
- 36% of gas goes to electricity and associated uses
- 19% to industry and other customers



(Source: Department of Energy and Climate Change)

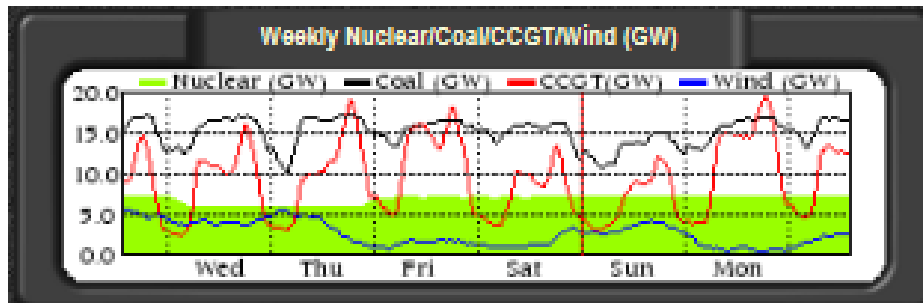
GHG emissions intensity for various sources of gas



(Potential Greenhouse Gas Emissions Associated with Shale gas Production and Use- DECC 2013)

Carbon impact: Displacement of coal

UK coal plants are being de-commissioned, but in the meantime, our electricity is coal heavy. Natural Gas has a role to play in the low carbon transition.



<http://www.gridwatch.templar.co.uk>

(Gridwatch 3 March 2014, 14:20)

Three key points

1

Shale gas is revolutionary and the UK will play a role in these changes

2

The UK shale gas industry must communicate its experience

3

Continued gas consumption must be one of the key strategies in reducing CO₂ emissions